Appendix 1-E

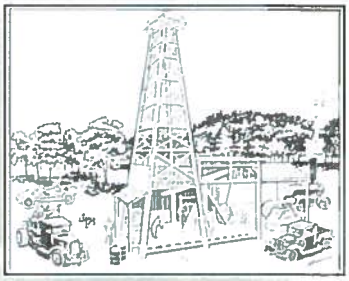
Mineral Oil-based Drilling Fluid Information

DRILLING FLUID DISCUSSION

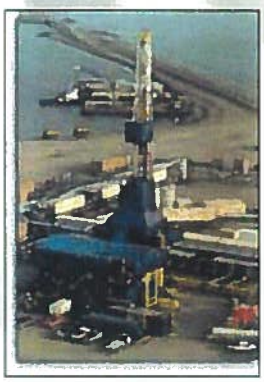
Northwest Territories Canada

- ## Drilling Mud

  - ### *WHAT IS DRILLING FLUID?*



- **In the oilfield, the liquid that drillers use to help drill the well is often referred to as, "mud" or "drilling mud". In the past, when people first started to drill oil wells, the fluid they circulated was mud. Roughnecks would mix local dirt and water to produce a thick slurry that the drillers would pump to help them drill the well. This was a good, fast and inexpensive way to help drill the well.**



- **As the search for oil and gas began to go deeper in the earth and as different formations were encountered, it wasn't long until simple mud would not allow the drillers to get to the oil and gas they needed to find.**
- **Drillers began to experiment by adding clays and other substances to make mud work better for them. Some of the first chemicals were clays added to water to make mud thicker and slicker than could be made from just dirt alone.**
- **Soon they began adding even more chemicals to control different aspects of the way the mud behaved and reacted with the formations that were encountered in drilling.**
- **It wasn't long until the simple mud of dirt and water became a complex blend of liquid and solid substances specially designed for drilling purposes. What started as simple mud has become a specially designed drilling fluid.**

  - ### *FUNCTIONS OF DRILLING FLUIDS*

- **Many people do not realize all the jobs that a modern drilling fluid must do. The functions (job) of a modern drilling fluid include:**
- **Control Subsurface Pressure - Often oil and gas are found under pressure beneath the earth – drillers will increase the weight of the drilling fluid by adding calcium carbonate. This will hold the oil and gas in place until drilling is finished and equipment can be installed to safely allow the oil and gas to be produced.**
- **Seal Permeable Formations - Special ingredients in the drilling fluid help to keep the fluid from leaking away into the formations**
- **Clean the hole - Transport and remove drilled cuttings - Suspend cuttings and weight materials and release cuttings at the surface.**

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DRILLING FLUID DISCUSSION

Northwest Territories Canada

- **Support weight of casing and drill string**
- **Prevent Reaction with drilled Shale formations**
- **Insure Maximum Hole Information – allow the geologist and other scientist to get the information they need.**
- **Clean, Cool, and Lubricate bit and drill string**
- **Transmit hydraulic horsepower to the bit**

- **Transmit data from MWD to surface**
- **Limit corrosion of tubular goods**

DRILLING FLUIDS MUST

- **Be Non-Damaging to - Producing Formations**
- **Be Friendly to Environment**

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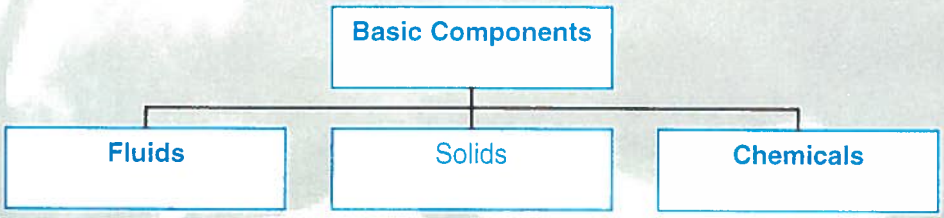
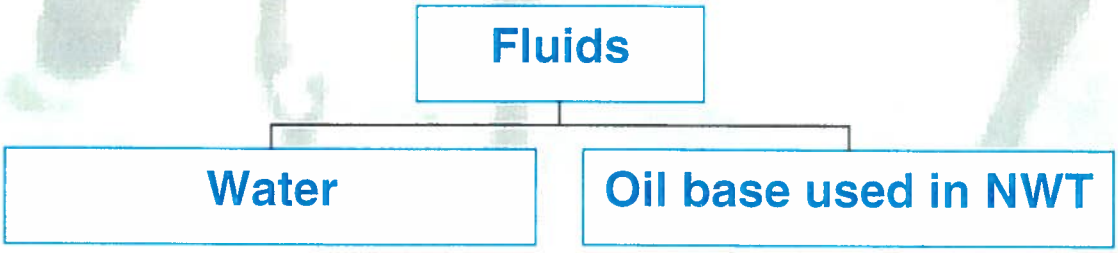
- *Ingredients of Drilling Fluids*
- *Drilling Fluids are made up of three basic ingredients*



- The **Fluid** used as the "**base**" will either be water or an oil base.



- Underneath the ground in the Normal Wells area there is a very thick bed of salt. As you know, salt will dissolve in water. To drill safely through a thick salt bed using a water base mud, salt must be added to the water until the drilling fluid becomes *salt saturated*. Salt saturated means you add more and more salt to the water until no more salt can dissolve in the drilling fluid. Once you have done this the thick salt bed it is not able to dissolve in the mud and you can safely drill through it.

- Another way to drill safely through the thick salt bed is to use an ingredient in the drilling fluid other than water. This is where oil base drilling fluids come in to the picture. Since salt will not dissolve into oil, oil can be used instead of a saturated salt mud to safely drill through thick salt beds.

- There are other advantages for drillers when using oil based drilling fluids. Remember some of the functions (jobs) of a drilling fluid mention before. One of the very important functions of a drilling fluid is to, "Prevent reaction with shale formations." Shales are stones found in many places where drillers look for oil. There are shales under the ground in the Norman Wells area. Shale is really just very old clay. Over the ages, as these clays become buried under other formations the water is pressed from them. Chemical changes also take place in the shale. The shale changes from being the soft clay we are all familiar with to a very hard stone. However, when these shales are exposed to the water in water based drilling fluid, they become reactive.

They will "drink" (absorb) the water from the drilling fluid. As shale absorbs water, it will begin to swell. If the shale swells while the drillers are working, the hole may try to close. This can make it very difficult and sometimes impossible finish drilling the well.

- Since shales do not "drink" oil , swelling shale is not a problem.

- Remember two of the things a drilling fluid MUST do? One of the things that a drilling fluid must be is non-damaging to the producing formation. If a drilling fluid damages the formation, drillers may not be able to get the oil and gas we need out of the formation. Oil Base drilling fluids are normally the least damaging to the formation.

- The other thing a drilling fluid MUST do is be ENVIROMENTALLY FRIENDLY! This is very important to everyone. The environment is important to the drillers and oil companies. The environment is important to the people, animals, plants, water and earth that live and are found where drillers work. It is important that we all carry out our activities in a way that allows people to benefit while at the same time minimizing the impact our activities have upon the earth.

- Any time people make something, there is always something left over. When you bake a cake there is often flour or dough left in the pan. A wise person will try to cook in a way where there is very little left over. This will save money and more importantly cut down on waste. Something similar happens when a well is drilled. When drilling a well, we are really making a very long hole. Dirt comes out of that hole (drillers call the dirt coming out of a hole "cuttings" since they are drilling with a bit). Cuttings are what is left over after drilling a well. Oil companies and drillers have plans for removing the left over cuttings (waste) in way that will not harm the earth. But, like a wise cook, drillers want to minimize the waste they deal with. This is another place where oil based fluids come into the picture – Oil base fluids help to minimize waste.

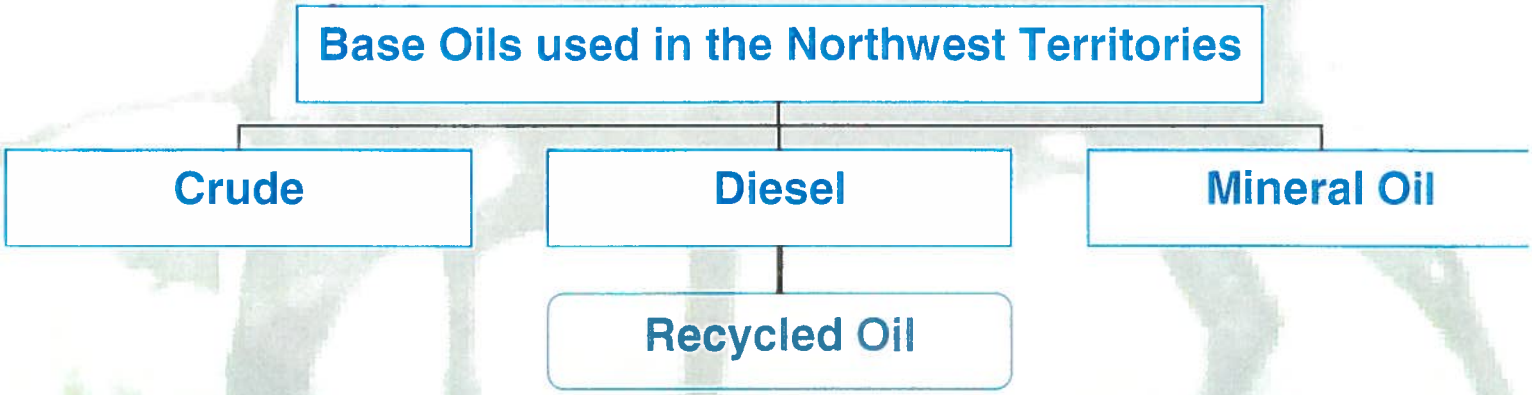
- Because shales and drilled solids are active in water, they can make the mud thick and impossible to drill with. There are machines that can take some of the shales out of the drilling fluid – but these machines cannot get all of the shales out of the fluid. When using a water based drilling fluid, to keep the mud from getting to thick and hard to work with, some of the drilling fluid is removed and more water has to be added to keep the level of the shale and solids low. It is like making bread. If you keep adding too much flour then you have to add more and more water. Before long, you have too much dough and have to do find something to do with it all! This is why it is very hard for drillers to use the same water based drilling fluid from well to well.

- Since shales don't react and dissolve in oil, the drillers can use less of an oil base mud than a water based fluid to drill the same well. Like a wise cook, using an oil base fluid can allow drillers to generate much less waste and oil based fluid can be re-used by drillers on many wells!

- If we use a salt saturated mud we must be concerned about the salt itself. A little bit of salt is good. Too much salt can be bad. If an accident should occur, salt can very difficult to clean up. Salt can mix with the earth and travel invisibly with water. Without doing chemical checks of the water or

seeing salt's effect upon plants, you might not even know an accident has occurred. It is easy see where a "small mess" might become a big one.

- An oil base mud is not as difficult to clean up. Oil does not mix well with the water or the ground. If an accident should occur, it is obvious. Oil tends to remain isolated where specialized crews can easily get to it and remove it from the environment before it causes permanent harm.



- "Oil" is a complex mixture with many different ingredients. There is no such thing as "pure" oil. Crude oil is oil straight from the ground. In some places it is used in drilling fluids. However, many of the ingredients in crude oil can be dangerous to living thing exposed to it. The ingredients in crude oil may change from place to place so it can be very difficult to say what may be in any crude oil.

- Diesel Oil is made from refined crude oil. Diesel oil is refined to a certain set of standards. We are able to know what should be in diesel and what should not be there. Diesel is used for drilling mud all over the world. These fluids are managed very carefully. While diesel is a much "cleaner" and better choice for a drilling fluid, there are still many compounds found in diesel that are not healthy for people or the environment.

- Recycled oil, like diesel is a refined product. Recycled oil can be environmentally attractive. Old oil from cars, trucks, boats, tractors and snowmobiles is cleaned-up, refined and re-used. This helps to reduce the waste stream that we all have had a part in creating. However, like diesel, there are many compounds are not healthy for people or the environment with long-term or repeated exposure.

- In Norman Wells, we recommend using a mineral oil in an oil based drilling fluid for use. This mineral oil is named Distillate 822. Distillate 822 is manufactured while making asphalt. In the process of making asphalt from bitumen, a high quality mineral oil is left over. This mineral oil is further refined to make Distillate 822. This highly refined mineral oil is missing many of the harmful components that are found in most other available oils. The level of remaining components, that may possibly pose a concern are drastically reduced from what would be found in the other oils. This makes this mineral oil much more environmentally friendly choice.

Steven Spence
Baker Hughes INTEQ Drilling Fluids - Canada

Some Points to Remember!

1. No matter if the drilling fluid is water mixed with other substances and chemicals or oil mixed with other substances and chemicals - both are called mud or "drilling fluids".

2. Both types of drilling fluids (water-based or oil-based) are used to drill wells all over the world.

3. There are times when one of these fluids is better to use than the other.

4. Consider the

Formation to be drilled:
- Water based drilling fluid
  - Will need to be saturated saturated
  - May have trouble controlling shales
- Mineral Oil Based Mud
  - Will have much less salt
  - Will control shales

Waste Stream
- Water Base Drilling Fluid
  - Water base require more dilution – the waste stream is larger and mud is very difficult to reuse.
  - Water would have to be saturated (filled to overflowing with salt).
  - It can be very difficult to remove salt from the soil
- Mineral Oil Base Drilling Fluid
  - Is more environmentally friendly than other available oils
  - Can drill without filling it up with salt because the salt body won't dissolve in the oil!
  - Will not require as much fluid because the drilled shales and solids won't react in it!
  - Fluid can be easily re-used many times from well-to-well – even season-to-season!
  - If an accident should happen, invert fluid can be isolated and removed easier!

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Moose Jaw Asphalt Inc.

MATERIAL SAFETY DATA SHEET

WHMIS CLASSIFICATION	
Combustible Liquid (Class B3) Poisonous Material (Class D1B) (Class D2B)	PRODUCT CODE: 180-822-7 CHEMICAL CODE: 3880-01 DATE: April, 2002

SECTION 1 – MATERIAL IDENTIFICATION	
Trade Name:	DISTILLATE 822
Other Names:	None
Chemical Synonyms and Family:	Petroleum Hydrocarbon
Name of Manufacturer/Supplier Address & Phone #:	MOOSE JAW ASPHALT INC. P.O. Box 2000 Moose Jaw, Sask. S6H 6E3 (306) 691-7800
Poison Control Centre Numbers:	Consult local telephone directory for emergency numbers.
Application:	Distillate 822 is used in the manufacture of flotation and spray oils, as well as other industrial applications.

SECTION 2 – TRANSPORTATION (NR – Not Regulated by TDG)			
UN Number:	NR	Primary Classification:	NR
Subsidiary Classification:	NR	Compatibility Groups:	NR
CANUTEC Transport Emergency Number:		(613) 996-6666	

SECTION 3 – COMPOSITION

Components	Allowable Limits (8 hr.)	% (Volume)	CAS #
Complex mixture of petroleum hydrocarbons* (C_{11} - C_{18})	5 mg/m^3 (oil mist)**	100	64741-44-2 64741-43-1

* Aromatic content is 20% maximum (Benzene nil).
** Moose Jaw Asphalt Inc. Recommendation

SECTION 4 – PHYSICAL DATA			
Density (at 15°C):	0.90 kg/L (approx.)	Boiling point/range (at 1 atm):	204-371°C (approx.)
Vapor Pressure(at 25°C):	<1 kPa	Percent Volatile (at 20°C):	25% in 10 hr. (approx.)
Vapor Density (at 20°C):	4.5 (approx.)	Evaporation Rate:	N/A
Solubility in Water:	Insoluble	Pour Point:	Unknown
Viscosity (Kinematic):	Max. 5.7 cSt (at 40°C)	Appearance and Odour:	Clear colorless oily liquid with hydrocarbon odour.

SECTION 5 – FIRE and EXPLOSION DATA

Flash Point (method used = TCC):	94°C (minimum)
Flammable limits in air (% by volume):	Lower 0.7% Upper 6.0%
Auto-Ignition Temperature:	>225°C
Fire and Explosion Hazards:	Treat as a flammable liquid.
Extinguishing Media:	Foam, dry chemical, water spray, carbon dioxide for small fires. Do not cut, drill or weld empty containers.
Firefighting Procedures:	Use full protective equipment and self contained breathing apparatus. Cover with extinguishing agent. Use water spray to cool fire-exposed containers and as a protective screen. Do not point solid water stream directly into burning oil to avoid spreading.
MODERATE FIRE HAZARD	

SECTION 6 – HEALTH HAZARD INFORMATION

Ingestion:	PRACTICALLY NON-TOXIC. Rat oral LD50 = >5 gm/kg. May cause gastrointestinal disturbances. Symptoms may include irritation, nausea, vomiting and diarrhea. Aspiration into lungs may cause pneumonitis. Exposure may cause central nervous system symptoms including CNS depression (narcosis) similar to those listed under "Inhalation" (see below).
Skin:	PRACTICALLY NON-TOXIC. Rabbit dermal LD50 = >2 gm/kg. MODERATELY IRRITATING. Rabbit dermal PSI = 3.2/8.0. Repeated or prolonged contact may result in defatting, oil acne, redness, itching, inflammation, cracking and possible secondary infection. Contact with heated material may cause thermal burns. This material was tested in a guinea pig dermal sensitization test and it is not considered a sensitizer.
Eyes:	SLIGHTLY IRRITATING. Rabbit Draize = 3.7/110 @ 1 hours (unwashed). Rabbit Draize = 1.0/110 @ 24 hours (unwashed). Exposure to vapors, fumes or mists may cause irritation. Contact with heated material may cause thermal burns.
Inhalation:	MODERATELY TOXIC. Rat 4-hour LC50 = 1.72 mg/L. May cause respiratory tract irritation. May cause harmful central nervous system effects. Effects may include excitation, euphoria, headache, dizziness, drowsiness, blurred vision, fatigue, tremors, convulsions, loss of consciousness, coma, respiratory arrest and death. Severe exposures may cause cardiac sensitization and irregular heart rhythm. Exposure to high concentrations of dense oil mists may lead to oil pneumonia.

Emergency and First Aid Procedures Information	
Skin:	Remove contaminated clothing - launder before reuse. Soap and water wash. Discard saturated leather articles.
Eyes:	Copious warm water flush - 15 minutes. Physician assessment mandatory.
Inhalation:	Evacuate to fresh air. Apply cardio-pulmonary resuscitation if required. Administer oxygen if available. If resuscitation is required, physician assessment mandatory.
Ingestion:	DO NOT INDUCE VOMITING. If vomiting - take care to prevent aspiration. Give 250 ml (1/2 pint) of milk to drink. Liquid paraffin may slow gastric absorption. Give activated charcoal tablets only if prescribed by physician. Physician assessment mandatory.
NOTE TO PHYSICIAN:	Gastric lavage should only be done after endotracheal intubation in view of the risk of aspiration which can cause serious chemical pneumonitis for which antibiotic and corticosteroid therapy may be indicated.

SECTION 7 - REACTIVITY DATA	
Stability:	Stable under normal storage and use.
Conditions to avoid:	Excessive heat, sources of ignition, formation of oil mist.
Materials to avoid:	Strong oxidizing agents (strong acids, peroxides, chlorine, etc.)
Hazardous decomposition products:	COx, SOx, smoke on combustion.
Can hazardous polymerization occur?	NO

SECTION 8 – SPILL OR LEAK PROCEDURES	
Steps to be taken if material is released or spilled:	Avoid contact. Use full protective equipment and breathing apparatus. ELIMINATE IGNITION SOURCES. Contain spill. Absorb with inert absorbent such as dry clay, sand or diatomaceous earth, commercial sorbents, or recover using electrically grounded explosion-proof pumps. Place absorbent in closed metal containers. DO NOT FLUSH TO SEWER.
Waste Disposal Method:	Incinerate at licensed waste reclaimer facility.

SECTION 9 – SPECIAL PROTECTION INFORMATION

Ventilation:	General ventilation. Use explosion-proof mechanical ventilation suitable for group D atmospheres.
Respiratory Protection:	Up to 5 mg/m^3 (oil mist), none required. From 5 to 50 mg/m^3, use an approved organic vapor respirator suitable for oil mist in areas with sufficient oxygen. Above 50 mg/m^3, use full-face air-supplied or self-contained breathing apparatus.
Protective Gloves:	Nitrile, Viton
Eye Protection:	Chemical goggles if splashing is likely.
Other Protective Clothing:	Chemical resistant clothing, if direct contact with liquid likely. DO NOT USE NATURAL RUBBER or PVC (polyvinyl chloride).

SECTION 10 – SPECIAL PRECAUTIONS

Store in cool, well-ventilated area. Electrically ground/bond during the pumping or transfer to avoid static accumulation. AVOID SKIN CONTACT and INHALATION. Practice good personal hygiene. DO NOT SIPHON BY MOUTH OR USE AS A CLEANING SOLVENT. Launder work clothes frequently. Moose Jaw Asphalt Inc. recommends an allowable exposure of 5 mg/m^3 (oil mist) when handling Distillate 822.

SECTION 11 - REFERENCES

ACGIH, Threshold Limit Values and Biological Exposure Indices for 1987-88.

CONCAWE, First Aid Measures, Medical Toxicology Data and Professional Advice to Clinicians on Petroleum Products, Feb. 1983.

API, Petroleum Process Stream Terms Included in the Chemical Substances Inventory Under the Toxic Substances Control Act (TSCA), 1983.

Environment Canada Manual for Spills of Hazardous Materials, March 1984.

NIOSH, The Industrial Environment - It's Evaluation and Control, 1973.

Patty's Industrial Hygiene and Toxicology, 3rd Edition, Vol. 2B, 1981.

API, The Toxicology of Petroleum Hydrocarbons, May 1982.

API, Acute Toxicity Tests, API # 79-6, 1980.

Canadian Centre for Occupational Health & Safety

Moose Jaw Asphalt Inc.

Prepared by Health and Safety